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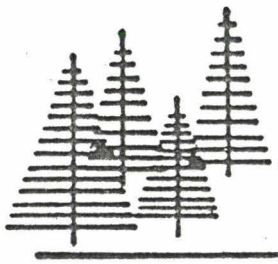

FOREST PEST MANAGEMENT

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INTERMOUNTAIN REGION

BIOLOGICAL EVALUATION OF WESTERN SPRUCE BUDWORM ON THE BEAVER RANGER DISTRICT, FISHLAKE NATIONAL FOREST, AND THE CEDAR CITY RANGER DISTRICT, DIXIE NATIONAL FOREST, UTAH--1982

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ABSTRACT

The western spruce budworm, Choristoneura occidentalis Free., continued to defoliate mixed conifer stands on the Beaver District, Fishlake National Forest, and on the Cedar City District, Dixie National Forest. A total of 54,640 acres was defoliated on the Fishlake and Dixie National Forests in 1982.

Average egg mass densities on the Beaver and Cedar City Districts remained at the same levels as those recorded in 1981. Stands defoliated in 1982 will sustain the same intensity of defoliation in 1983. Heaviest defoliation will continue to occur in the Kent Lake area on the Beaver District, and in the Navajo Lake, Mammoth Creek, and Yankee Meadow areas on the Cedar City District. Defoliation will be light to moderate in the Strawberry Creek area, and light to undetectable in the Cedar Canyon, Duck Creek, Brian Head, and Cedar Breaks areas on the Cedar City District. The western spruce budworm outbreak is expected to continue for several more years on the Fishlake and Dixie National Forests.

INTRODUCTION

The western spruce budworm, Choristoneura occidentalis Free., continued to defoliate mixed conifer stands on the Fishlake and Dixie National Forests. Visible defoliation was first observed in 1980 during aerial surveys on 5,000 acres in the Red Creek, Little Creek, and Caddy Creek drainages east of Paragonah, Utah, on the Cedar City District, Dixie National Forest. Noticeable defoliation occurred on the Beaver District of the Fishlake National Forest in 1981, covering 1,500 acres. In 1982, the amount of visibly defoliated acreage continued to increase in size and intensity. Egg mass surveys were conducted in the Kent Lake area on the

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EXPERIMENT STATION

Beaver District and scattered throughout the southern half of the Cedar City District. Biological data are summarized in this evaluation, with a presentation of management alternatives and recommendations.

TECHNICAL INFORMATION

Insect - Western spruce budworm, Choristoneura occidentalis Freeman

Host - Douglas-fir, Pseudotsuga menziesii (Mirb.) Franco
White fir, Abies concolor (Gord. and Glend.) Lindl.
Subalpine fir, Abies lasiocarpa (Hook.) Nutt.
Blue spruce, Picea pungens Engelm.
Engelmann spruce, Picea engelmannii Parry.

Life History - The western spruce budworm completes one generation each year (Furniss and Carolin 1977).

Stage	Time	Location on Host
Egg	August	On needles
Small larvae	Overwinter	In hibernaculum (silken cocoons) on branches and trunk
Large larvae	June-July	On buds and cones
Pupae	July-August	On foliage
Adults	August-September	In flight

Evidence of Infestation

1. Young larvae feeding on newly expanding buds and strobile.
2. Mature larvae consuming current year's needles.
3. Shoots webbed together by larvae.
4. Webbed shoots turning brown and falling from trees.
5. Defoliation most evident in upper crowns of trees.
6. Trees dying from top downward after several years of heavy defoliation.

Extent of the Defoliation in 1982 - Defoliation was visible from the air on 43,360 acres on the Beaver District and 11,280 acres on the Cedar City District. Severity of defoliation was categorized as light, medium, and heavy. Acres of defoliation on each District are as follows:

Forest	District	Light	Moderate	Heavy	Total
Fishlake	Beaver	29,760	10,800	2,800	43,360
Dixie	Cedar City	80	7,960	3,240	11,280
TOTAL		29,840	18,760	6,040	54,640

Defoliation caused by western spruce budworm was observed on 43,360 acres of spruce-fir type from Rattlesnake Peak south to Chokecherry and South Creek Peaks on the Beaver District. Areas of visible defoliation on the Cedar City District of the Dixie National Forest occur from Little Creek Peak southwest to Brian Head Ski Area, covering 11,280 acres. Figures 1 and 2 show the defoliation that occurred on the Beaver and Cedar City Ranger Districts, respectively.

BIOLOGICAL INFORMATION

Relative Abundance of Pest

Methods - Egg mass surveys were conducted in late August to provide an indication of larval densities and corresponding defoliation expected to occur in 1983. Samples were taken from 30 plots randomly distributed on the two Districts within the infestation. Two branches (70 cm in length) were cut from opposite sides of the midcrown of three sample trees on each plot. Sample trees met the following criteria: Douglas-fir, dominant or codominant; 30-50 feet in height; relatively open grown with a full crown; and some budworm feeding evident, but the tree could not be severly defoliated or top-killed. Each branch was individually bagged in large cloth bags, tied, labeled, and transported to a laboratory for examination. All sacks were stored in a walk-in cooler at 40° F.

In the laboratory, the foliage was examined under ultraviolet light for budworm egg masses. Needles bearing egg masses were classed as from current year's foliage, or a previous year's foliage, and kept separate in labeled petri dishes. Egg masses were separated into new or old categories. All egg masses on current year's foliage were classed as new, and their characteristics formed the basis for aging egg masses found on previous year's foliage.

Defoliation predictions for 1983 were determined from the number of new egg masses per square meter of foliage (EM/m^2), as calculated using the following formula:

$$EM/m^2 = \text{Number of new egg masses} \div \{(\text{Branch Length cm} \times \text{Branch Width cm})/ 2 \times 10{,}000\ cm^2\}$$

Defoliation predictions for 1983 were also determined from the density of 1982 egg masses, using the following information developed by McKnight et al. (1970):

Egg mass density (EM/m^2)	Predicted defoliation class [a/]
<1.55	Undetectable for all infestations
1.71 to 6.20	Undetectable for "static" infestations Light for "increasing" infestations
9.30 to 31	Light for "static" infestations Moderate for "increasing" infestations
>34.10	Moderate for "static" infestations Heavy for "increasing" infestations

[a/] Defoliation class limits (percent of new growth)
Undetectable = < 5 percent
Light = 5 to 35 percent
Moderate = 35 to 65 percent
Heavy = > 65 percent

The current year (1982) defoliation was determined by examining each 70-cm branch to establish the defoliation class (percent defoliation). Defoliation classes were assigned midpoint values for computation purposes as described:

Defoliation class	Index value	Midpoint value
0	0	0
1-25	1	12.5
26-50	2	37.5
5175	3	62.5
76-99	4	87.5
100	5	100

The midpoint values of six branches were averaged to determine the percent plot defoliation.

Results and Discussion - Results of the 1982 Egg Mass and Defoliation Survey are presented separately for each District. Table 1 shows a summary of the egg mass and defoliation data on the Beaver and Cedar City Ranger Districts.

Beaver District, Fishlake National Forest - Egg mass survey data from the Kent Lake area indicates that budworm populations will remain at relatively high levels in 1983. The average egg mass density was 24.9 egg masses per meter square of foliage, down from 68.17 in 1981, probably due to the unusually wet weather experienced in the area. However, both figures represent a very heavy predicted defoliation for the following year. The 1982 average level of defoliation of the branches sampled was 68.31 percent.

Cedar City District, Dixie National Forest - Egg mass survey data were taken in different areas in 1981 and 1982, except in the Yankee Meadow Reservoir area. There were no egg masses located on branches taken from the plots in the Cedar Canyon Campground, Duck Creek Campground, and Brian Head and Cedar Breaks areas. The predicted defoliation in these areas for next year is light to undetectable. The Cedar Canyon and Duck Creek plots received 10.42-percent and 8.33-percent defoliation, respectively.

The Strawberry Creek area had an average of 4.6 egg masses per plot and a density of 3.7 EM/m^2. Defoliation averaged 16.9 percent and is predicted to be light to moderate in 1983.

Navajo Lake Campground had an average of 12 egg masses per plot and a density of 12 EM/m^2. Plot defoliation was 35.4 percent and is predicted to be moderate to heavy in 1983.

Mammoth Creek had an average of 6.7 egg masses per plot and a density of 5.2 EM/m^2. Average defoliation was 12.5 percent and is predicted to be light in 1983.

Yankee Meadow remained static from 1981 to 1982, with only a slight increase of 23.5 to 24 egg masses per plot and a density of 18.96 to 19.86 EM/m^2. Plot defoliation was 70.83 percent and is predicted to be moderate to heavy in 1983. This area had the greatest number of egg masses per plot, density of egg masses per square meter of foliage, and highest percent of defoliation in 1982.

MANAGEMENT ALTERNATIVES

No Action - With this approach, the outbreak would be allowed to run its course until a population collapse occurred from a combination of: (a) a lack of foliage to maintain a larval population; (b) unfavorable weather conditions; (c) heavy predation and parasitism; and (d) a microbial epizootic. The following adverse and beneficial effects of the outbreak would have to be accepted:

1. This alternative would not be effective in preventing additional tree damage. Impacts to resource values and uses caused by the budworm would have to be accepted under this alternative. Although damage resulting from the western spruce budworm in Utah is not completely known, damage similar to those estimated for the Pacific Northwest could occur if the outbreak continues unabated (Parker 1979). Resultant damage occurring over a typical 10 to 15-year outbreak include the following:

Tree damage	Maximum loss (percent)
Growth loss	30
Understory mortality	25
Sawtimber mortality	5
Topkilling	25
Cone crop reduction	90+
Christmas tree-use reduction	90+

2. There would be no direct costs associated with selection of this alternative, although timber values will be affected and revenues reduced when severely damaged stands are harvested. Also, the depletion of the understory could necessitate the expenditure of funds for reforestation.

3. Visual qualities and economic and social impacts would continue if this alternative was selected.

Silvicultural Management - The main objective of this alternative is to promote effective timber management of the mixed-conifer type to reduce the impact of the western spruce budworm and other forest pests. Thus, stand conditions that reduce tree damages over the long term are created. For example, prescriptions should: (a) open up stands by logging, thinning, and burning; (b) maintain stand densities favoring ponderosa pine and aspen; (c) favor prescribed burning to reduce the percentage of firs and Engelmann spruce; (d) regenerate stands by artificial means, using ponderosa pine stock; (e) favor evenaged stands; and (f) salvage damaged and insect-killed trees.

Effects of this alternative are:

1. The trend of the current outbreak would not be changed if a silvicultural program was initiated. Tree damages would be similar to those listed under the "No Action" alternative; however, topkilling and mortality to understory regeneration could be reduced in areas entered during the current outbreak.

2. Visual qualities and economic and social impacts would continue if this alternative were selected.

Direct Suppression - Aerial application of a pesticide registered by the U.S. Environmental Protection Agency (EPA) could be made to suppress all or part of the outbreak on the Forest. However, if only part of the infestation is treated or if adjoining lands are not treated, one or two additional treatments may be required during the infestation cycle since treated stands could be reinfested from nearby untreated areas.

Application would be carefully timed to the development of the larvae and bud flush; i.e., when 20 percent of the larvae are in the fifth and sixth instars and

buds are 85 to 90 percent flushed. This would insure maximum effectiveness with a minimum dosage of insecticide. An application of this type is designed to utilize indigenous natural control agents to further reduce and maintain the budworm population at a low level.

Effects of this alternative are:

1. If a direct suppression program were to be carried out on the Forest in 1983, tree damages and losses could be reduced in areas where permanent tree damages have not yet occurred. However, once permanent tree damages have occurred, the direct suppression alternative may no longer be practical.

2. Although there would be immediate costs associated with the application of a pesticide, about $10-per-acre positive benefits could be achieved by preventing additional effects to timber and recreational activities.

3. Adverse environmental effects resulting from the application of a pesticide would be minimal and temporary.

Insecticides registered for use against the budworm follow:

1. Carbaryl (carbamate insecticide)

The Sevin 4 oil formulation of carbaryl has given consistently satisfactory results in suppressing budworm outbreaks throughout the West for a minimum of 3-4 years. Carbaryl is a nonpersistent pesticide which is available for general use. One pound of active ingredient per acre is the registered dosage rate, and no lasting environmental effects have been identified at this application rate.

2. Acephate (organophosphate insecticide)

Orthene is a nonpersistent insecticide registered for use against the western spruce budworm and other forest defoliators. This insecticide was successfully used against the budworm on the Boise National Forest in 1979.

3. Malathion (organophosphate insecticide)

Malathion is a nonpersistent, broad-spectrum insecticide, registered for use against more than 100 insects, including the western spruce budworm. However, it is not recommended because it has yielded inconsistent results in suppressing outbreaks.

4. Microbial Insecticides

Microbial insecticides such as Bacillus thuringiensis Berliner (B.t.), a bacterium, and viruses need further testing and field evaluation before they are ready for use. In 1981, two B.t. formulations were pilot tested by the USDA Forest Service and New Mexico Departments of Agriculture and Natural Resources near Eagle Nest, New Mexico. Preliminary results show that larval mortality was greater in sprayed areas than in check blocks. If treatment is necessary, B.t. could be used in sensitive areas, such as along waterways and near lakes and near specific wildlife areas.

Treatment of High-Value Trees - In recreation areas, VIS centers, and other areas where defoliation of high-value trees would be unacceptable, individual or small groups of budworm-infested trees could be treated by a ground application of an EPA-registered insecticide to reduce the larval density and prevent the adverse effects of defoliation.

Effects of this alternative are:

1. Because only selected high-value trees within an infestation would be treated, this would require annual applications during the outbreak cycle, since treated trees would be reinfested from the nearby infestation.

2. Application costs associated with this alternative would have to be accepted.

3. Adverse environmental effects would be minimal and temporary.

RECOMMENDATIONS

Management of the Current Western Spruce Budworm Outbreak - Recommendations for managing the western spruce budworm are based on the age, extent, and intensity of the current outbreak. In the past 3 years, the outbreak has caused scattered, light-to-moderate defoliation on the Beaver and Cedar City Districts. Generally, budworm outbreaks last from 10 to 15 years causing resource damage after 4 to 5 years of repeated heavy defoliation. However, this has not been observed in Utah. Since the current outbreak is only in the third year of light-to-moderate defoliation, unacceptable impacts to the resources are not anticipated in 1983. If the current outbreak should intensify with increasing heavy defoliation, subsequent unacceptable losses due to growth reduction, topkill, and mortality, may accrue. A biological evaluation should be conducted annually during the current outbreak to assess changes in the insect population and tree damage.

Land management objectives for some areas within the infested area, such as high-value areas, may justify partial treatment. Such areas within the infestation would need to be examined on an individual basis to determine the best management alternative.

Long-term silvicultural management for western spruce budworm on these Districts can be accomplished by including pest management considerations into existing and future timber and fire management programs. For example, these management programs should facilitate the removal of susceptible old growth and favor ponderosa pine, Douglas-fir, and aspen in vigorous, even-aged mixed conifer stands. These stands should be noncontiguous and evenly distributed by age class.

LITERATURE CITED

Furniss, R. L., and V. M. Carolin. 1977. Western forest insects. USDA, Forest Serv. Misc. Publ. No. 1339. 654 p.

McKnight, M. E., J. F. Chansler, D. B. Cahill, and H. W. Flake, Jr. 1970. Sequential plan for western spruce budworm egg mass surveys in the central and southern Rocky Mountains. USDA, Forest Serv. Res. Note RM-174. 5 p.

Parker, Douglas L. 1979. Biological Evaluation Western Spruce Budworm - Kaibab National Forest and Grand Canyon National Park. USDA Forest Serv. R-3 79-13. 17p.

Parker, Douglas L., and Iral R. Ragenovich. 1980. Western spruce budworm suppression and evaluation project using carbaryl, 1979. USDA, Forest Serv. Progress Rep. No. 3. R-3 80-1. 56 p.

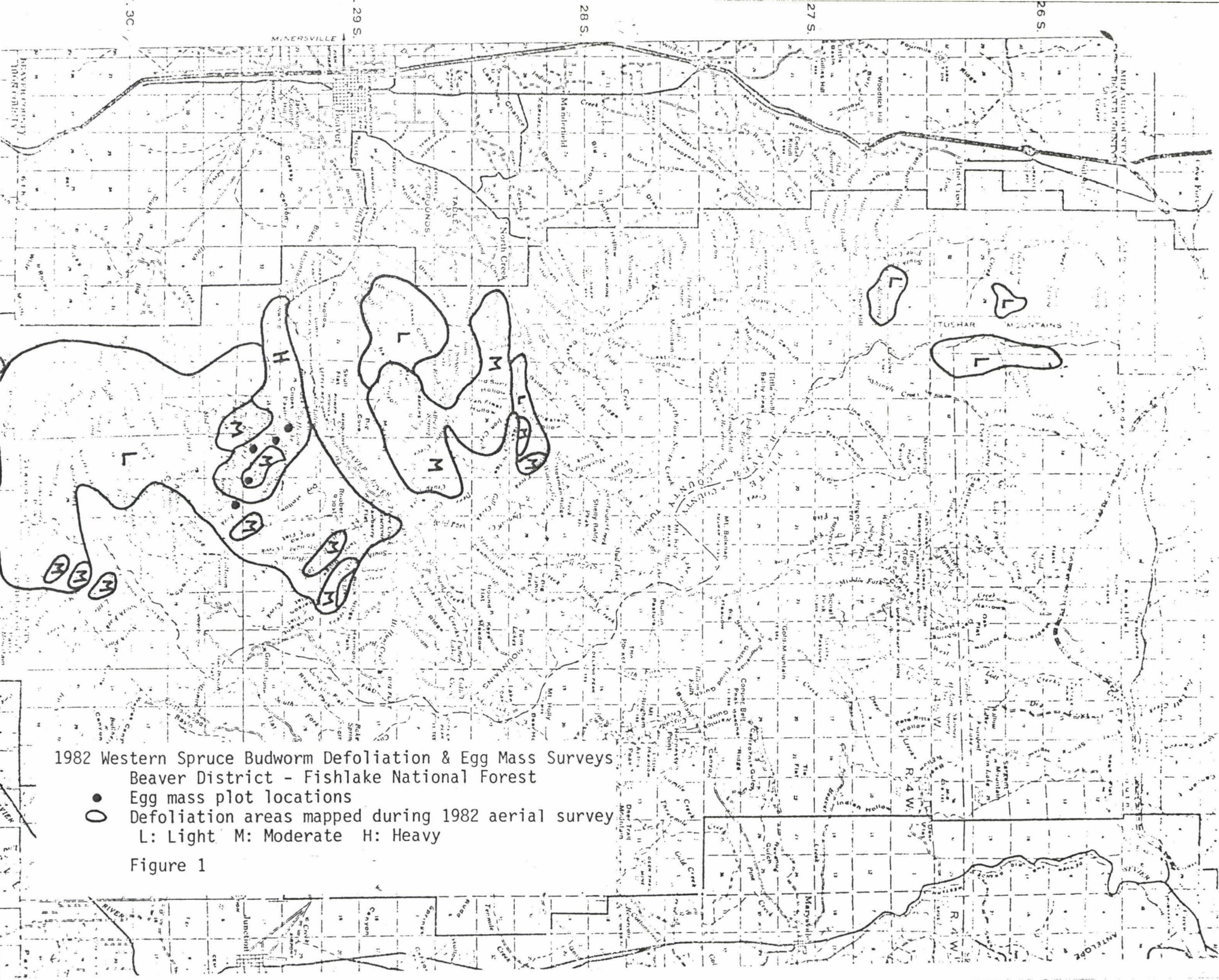
Rogers, T. J. 1982. Biological evaluation western spruce budworm, Carson National Forest, New Mexico. USDA, Forest Serv. R-3 83-2. 19 p.

Telfer, William G., Iral R. Ragnovich, and T. J. Rogers. 1982. Western spruce budworm suppression project using carbaryl, 1977. USDA, Forest Serv. Progress Rep. No. 5. R-3 82-7. 17 p.

Table 1. Summary of the egg mass and defoliation data for Fishlake and Dixie National Forests.

	No. Plots	New Egg Masses Per m^2 Foliage	Observed Defoliation[1] 1981	Observed Defoliation[1] 1982	% Plot Defoliation 1982	Predicted Defoliation 1983
FISHLAKE NF						
Kent Lake	5	24.9	H[2]	H[2]	68.3	H[2]
DIXIE NF						
Brian Head	2	0	U	U	0	U
Cedar Breaks	2	0	U	U	0	U
Cedar Canyon	1	0	U	U	10.4	U
Duck Creek	2	0	U	U	8.3	U
Mammoth Creek	7	5.2	U	U	12.5	L
Navajo Lake	2	12.0	U	U	35.4	M
Strawberry Creek	8	3.7	U	U	16.9	L
Yankee Meadow	1	19.9	L	M	70.8	M

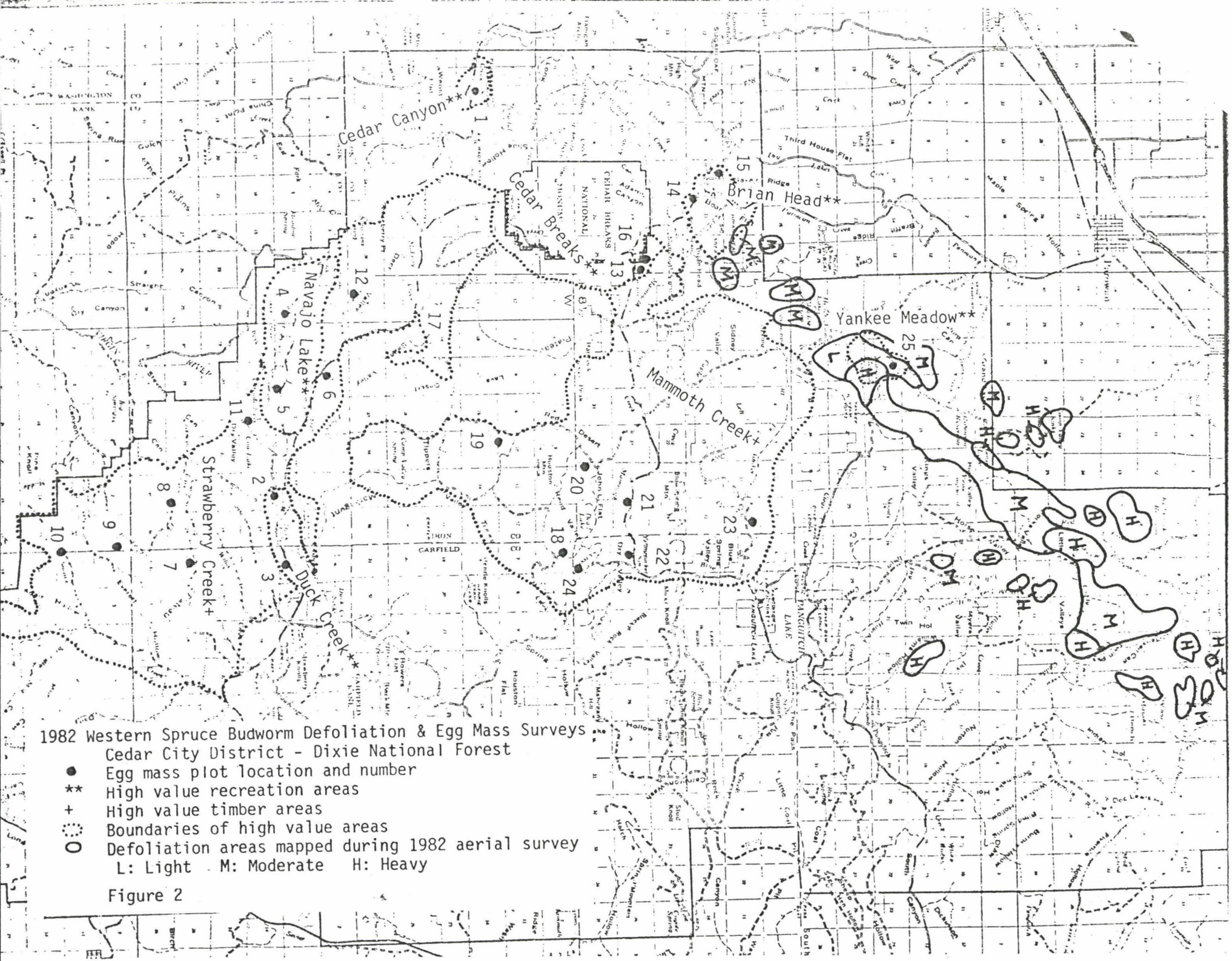
[1] Defoliation observed during aerial surveys.
[2] Defoliation classes are as follows: U = undetectable, L = light, M = moderate, H = heavy.



1982 Western Spruce Budworm Defoliation & Egg Mass Surveys
Beaver District - Fishlake National Forest

- ● Egg mass plot locations
- ○ Defoliation areas mapped during 1982 aerial survey
  L: Light M: Moderate H: Heavy

Figure 1



1982 Western Spruce Budworm Defoliation & Egg Mass Surveys
Cedar City District - Dixie National Forest

- ● Egg mass plot location and number
- ** High value recreation areas
- \+ High value timber areas
- ⬚ Boundaries of high value areas
- O Defoliation areas mapped during 1982 aerial survey
  L: Light M: Moderate H: Heavy

Figure 2

EGG MASS SURVEY - DIXIE NATIONAL FOREST (1982)

Unit	Species	Plot #	EM/m^2 Branch 1	Branch 2	Branch 3	Branch 4	Branch 5	Branch 6	Average EM/m^2	EM Plot	1982 % Plot Defoliation	1983 Defoliation % & Damage Category Total	EM/Plot	Predicted Defoliation for 1983 (EM/m^2)
CC	DF	1	0	0	0	0	0	0	0	0	10.42	0-25	Light	Undetectable
DC	DF	2	0	0	0	0	0	0	0	0	14.58	0-25	Light	Undetectable
DC	DF	3	0	0	0	0	0	0	0	0	2.08	0-25	Light	Undetectable
NL	DF	4	28.57	14.29	7.14	0	0	17.14	11.19	12	58.3	41-55	Heavy	Moderate
NL	DF	5	0	19.05	9.52	16.33	26.37	0	11.88	12	12.5	41-55	Heavy	Moderate
SC	DF	6	26.67	31.75	23.81	36.73	12.24	14.29	24.25	31	37.5	56-100	V. Heavy	Moderate
SC	DF	7	0	0	0	0	0	0	0	0	6.25	0-25	Light	Undetectable
SC	DF	8	0	0	0	0	0	0	0	0	12.5	0-25	Light	Undetectable
SC	DF	9	0	4.76	0	4.40	0	0	1.53	2	14.58	0-25	Light	Undetectable
SC	DF	10	0	0	0	5.71	0	5.19	1.82	2	8.3	0-25	Light	Light
SC	DF	11	0	0	0	11.43	0	0	1.9	2	41.66	0-25	Light	Light
SC	DF	12	0	0	0	0	0	0	0	0	4.16	0-25	Light	Undetectable
SC	DF	17	0	0	0	0	0	0	0	0	10.42	0-25	Light	Undetectable
BH	DF	14	0	0	0	0	0	0	0	0	0	0-25	Light	Undetectable
BH	SAF	15	0	0	0	0	0	0	0	0	0	0-25	Light	Undetectable
CB	SAF	16	0	0	0	0	0	0	0	0	0	0-25	Light	Undetectable
CB	SAF	13	0	0	0	0	0	0	0	0	0	0-25	Light	Undetectable
MC	DF	18	0	0	0	0	0	0	0	0	0	0-25	Light	Undetectable
MC	DF	19	7.14	0	0	11.43	0	0	3.10	3	10.42	26-40	Moderate	Light
MC	SAF	20	4.39	57.14	52.38	31.75	0	14.29	26.66	35	20.83	56-100	V. Heavy	Moderate
MC	DF	21	0	0	0	0	0	0	0	0	27.08	0-25	Light	Undetectable
MC	DF	22	15.24	11.43	0	0	0	4.39	5.18	7	14.58	41-55	Moderate	Light
MC	DF	23	0	0	0	0	0	0	0	0	6.25	0-25	Light	Undetectable
MC	DF	24	0	0	0	0	8.79	0	1.47	2	8.3	0-25	Light	Undetectable
YM	DF	25	38.10	46.75	19.05	0	7.62	7.62	19.86	24	70.83	41-55	Heavy	Moderate

CC - Cedar Canyon Campground, DC - Duck Creek Campground, NL - Navajo Lake Campground, SC - Strawberry Creek
BH - Brian Head, CB - Cedar Breaks, MC - Mammoth Creek, YM - Yankee Meadow, DF - Douglas Fir, SAF - Subalpine Fir

EGG MASS SURVEY - FISHLAKE NATIONAL FOREST (1982)

Unit	Species	Plot #	EM/m^2 Branch 1	Branch 2	Branch 3	Branch 4	Branch 5	Branch 6	Average EM/m^2	EM Plot	1982 % Plot Defoliation	1983 Defoliation % & Damage Category Total	EM/Plot	Predicted Defoliation for 1983 (Em/m^2)
D-3	DF	1	0	4.08	0	5.71	0	11.43	3.54	4	72.9	26-40	Moderate	Light
D-3	DF	2	3.81	45.7	15.58	19.05	15.58	8.79	18.09	21	68.75	41-55	Heavy	Moderate
D-3	DF	3	57.14	25.97	10.99	31.17	11.43	16.33	25.51	28	58.3	56-100	V. Heavy	Moderate
D-3	DF	4	11.11	25.25	51.43	39.44	61.90	119.48	51.44	59	83.3	56-100	V. Heavy	Heavy
D-3	DF	5	17.14	5.19	25.57	12.24	48.35	47.62	26.02	33	58.3	56-100	V. Heavy	Moderate

D-3 - Beaver Ranger District, Kent Lake Area; DF - Douglas Fir

PESTICIDE USE STATEMENT

Pesticides used improperly can be injurious to man, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers under lock and key -- out of the reach of children and animals -- and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you use for herbicides.

Dispose of empty pesticide containers promptly. Have them buried at a sanitary land-fill dump, or crush and bury them in a level, isolated place.

NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the U. S. Department of Agriculture, consult your county agricultural agent or State Extension specialist to be sure the intended use is still registered.